UNIVERSITY OF ALBERTA LIBRARY
0 0001 8210 161

SD
145
T25
no.0010

SCI

Ex Libris
Universitatis
Albertaensis

7-10
BRARY OF THE UNIVERSITY
OF ALBERTA
27. JUL 1955

CANADA
Department of Northern Affairs and National Resources
FORESTRY BRANCH

SURVIVAL OF WHITE SPRUCE REPRODUCTION RESULTING FROM VARIOUS METHODS OF FOREST SOIL SCARIFICATION

ONE WEEK LOAN
GENERAL SCIENCES

by

D. I. Crossley

Forest Research Division
Technical Note No. 10
1955

Published under the authority of
The Minister of Northern Affairs and National Resources
Ottawa, 1955

UNIVERSITY
OF ALBERTA LIBRARY

CONTENTS

	Page
Introduction	3
Results	4
Discussion	7
Conclusions	9
Summary	9
References	9

2476943

SURVIVAL OF WHITE SPRUCE REPRODUCTION RESULTING FROM VARIOUS METHODS OF FOREST SOIL SCARIFICATION

PROJECT K. 47

by

D. I. CROSSLEY

INTRODUCTION

An investigation of the problem of reproducing clear cut, non-regenerating white spruce stands, *Picea glauca* (Moench) Voss. var. *Albertiana* (S. Brown) Sarg., was initiated on the Kananaskis Forest Experiment Station at Seebe, Alberta, in 1948. Both fire and heavy mechanical equipment were utilized to break up and reduce the competition from the heavy grass sod which invades high lime forest soils in this subalpine forest region, and both natural and artificial seeding were employed after the forest floor preparation had been completed.

Because of a light seed crop in the marginal spruce stand, the north half of each treated plot was seeded artificially by broadcast methods. In this investigation seed traps indicated that natural seeding on the study area had occurred at the rate of 56,000 seeds per acre. Broadcast seed was applied at 25 times this rate (or 1,400,000 seeds per acre) with viability tested at 55 per cent. Four 1/3-milacre quadrats were laid out in each plot (half-acre) for detailed study of germination and subsequent mortality. These quadrats were screened following seeding in order to prevent loss to birds and rodents, the screens being removed the following spring.

At the conclusion of the second growing season after treatment, initial germination appeared adequate in all cases where seed was artificially applied, and in some cases was remarkably abundant. (This was noted in a report by the author published in 1952.). At the same time mortality had eliminated the regeneration on the untouched control and had reduced considerably the number on the treated areas. A 20 per cent stocking sample revealed that only two of the treated areas were under-stocked. It was also evident that the scarification of the forest floor on a non-reproducing cut-over area effectively increased its receptivity to spruce regeneration, and it appeared that the more complete the baring and compaction of the mineral soil, the greater the germination and survival. The extremely high rate of survival on many of

the treated areas at the conclusion of the second season caused some concer and the above mentioned report closed with the statement that the investigi tion would continue until final survival was established.

This Technical Note presents the results three years later, or five yea after the study was initiated. Mortality has been tallied on the study quadra in the autumn of each succeeding year, and in the fifth year a stocking tal was completed by the stocked-quadrat method, using a milacre as the un area.

RESULTS

The treatment each plot received and the results at the conclusion of th fifth season are presented in Table 1. In some cases the nature of the equip ment used is self-evident but in others a brief explanation is in order. Th "punch-packer" is a locally-designed implement, somewhat similar in desig to a sheep-foot packer used in road building. Through its use numerous smal depressions are punched through the duff into the mineral soil, and at the sam time the surface soil is firmed by the weight of the packer. The depressions serve as localized individual seed-beds. A crow-bar placed across the fram so that one set of punches caught against it and prevented the rolling motio resulted in the "locked punch-packer". The lower set of punches ripped through the soil surface instead of punching depressions into it. "Swinging tracks" refers to the use of a crawler-type tractor, which, by advancing with alternat tracks powered, pivoted about the locked track. The growser plates tore of the humus as they swung through an arc, leaving bare scored mineral soil For further details of treatment reference should be made to the 1952 repor previously mentioned.

TABLE 1—PER ACRE RESULTS ON THE STUDY QUADRATS IN THE AUTUMN OF 195 AFTER FIVE SEASONS

Plot No. and Treatment	Germination				Per cent Mortality				Survival			
	Artificial		Natural		Artificial		Natural		Artificial		Natural	
	Seed Source		Seed Source		Seed Source		Seed Source		Seed Source		Seed Source	
	weS	alF	weS	alF	weS	alF	weS	alF	weS	alF	weS	alF
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12
1. Athens disc	274,500	3,000	0	0	91·3	100·0	.....	.....	24,000	0	.....	.....
2. Athens disc after burning.	280,500	1,500	0	0	87·7	100·0	.....	.....	34,500	0	.....	.....
3. Locked punch-packer	165,000	1,500	3,000	0	83·6	100·0	100·0	.....	27,000	0	0	.....
4. Athens disc and punch-packer	469,500	0	10,500	3,000	81·5	.....	57·1	0·0	87,000	.....	4,500	3,00
5. Burned	297,000	0	1,500	0	94·9	.....	100·0	.....	15,000	.....	0	.....
6. Bull-dozer	961,500	0	4,500	0	79·6	.....	100·0	.....	196,500	.....	0	.....
7. Snagged tree trunks	186,000	0	1,500	0	97·6	.....	0·0	.....	4,500	.....	1,500	.....
8. Swinging tracks after burning	639,000	4,500	18,000	0	71·1	100·0	100·0	.....	184,500	0	0	.....
9. Control No. 1	21,000	0	0	0	71·4	.....	.....	.....	6,000	.....	.....	.....
10. Punch-packer	9,000	0	0	0	100·0	.....	.....	.....	0	.....	.....	.....
11. Punch - packer after burning	477,000	1,500	3,000	0	78·6	100·0	100·0	.....	102,000	0	0	.....
12. Swinging tracks	108,000	0	3,000	1,500	56·9	.....	50·0	100·0	46,500	.....	1,500	(
13. Control No. 2	3,000	0	1,500	0	100·0	.....	100·0	.....	0	.....	0	.....

Figure 1 graphically compares the 1949 germination and subsequent survival of white spruce over the five-year period on each of the variously disturbed seed-beds that were artificially seeded.

Fig. I

Comparative germination, and mortality over a five-year period, of artificially seeded White Spruce on variously disturbed forest floors.

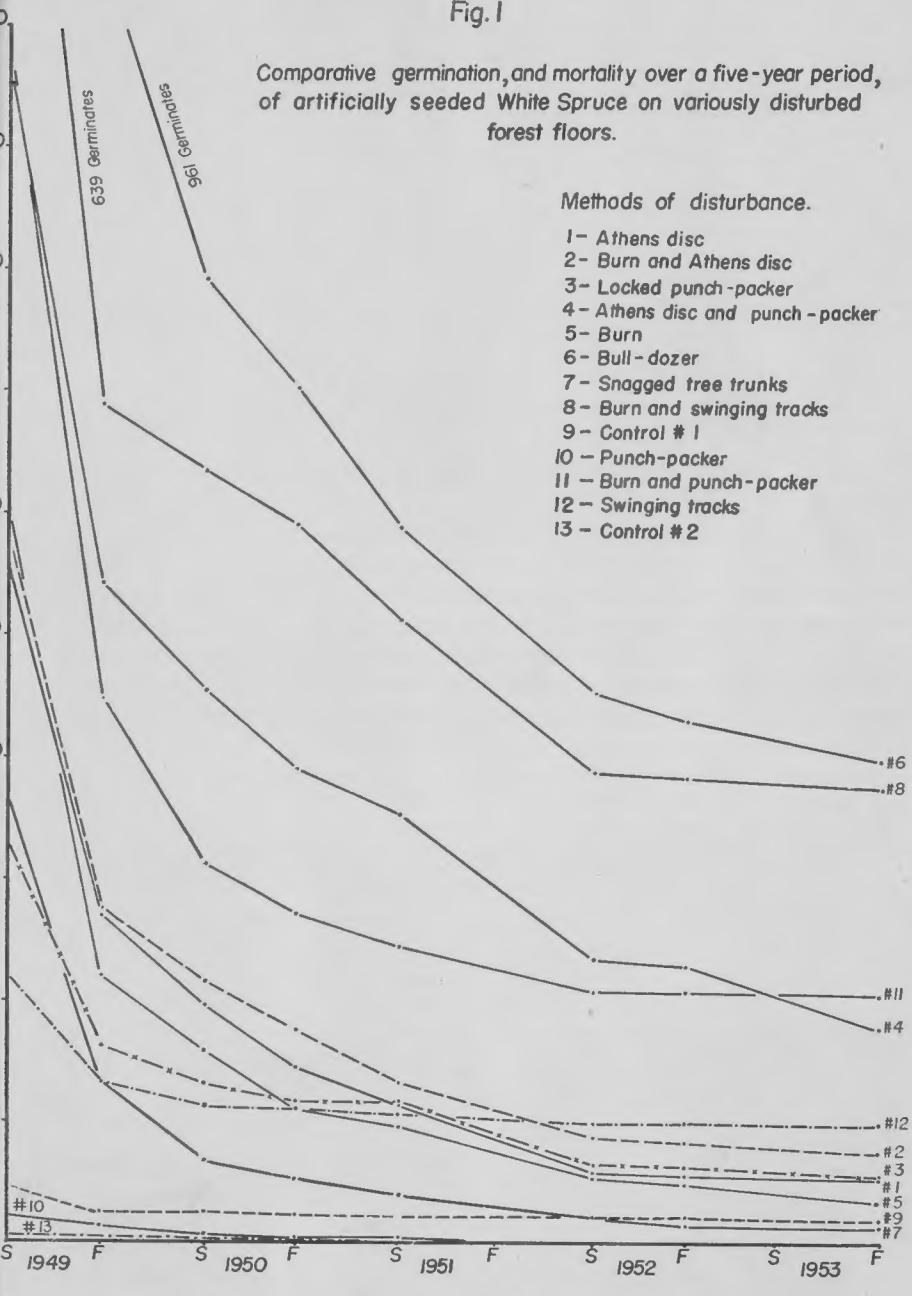

TABLE 2—STOCKING RESULTS AFTER FIVE YEARS, ARRANGED IN ORDER OF SUCCESS, IN RELATION TO ARTIFICIAL SEEDING (COTYLEDONOUS SEEDLINGS EXCLUDED)

Plot No. and Treatment	Per cent Stocking		Estimated* Number of Seedlings per Acre (Artificial Seed Source)
	Natural Seed Source	Artificial Seed Source	
	(1)	(2)	(3)
6. Bull-dozer	34	90	2,250
4. Athens disc and punch-packer	36	84	1,950
1. Athens disc	26	80	1,700
2. Athens disc after burning	20	80	1,700
12. Swinging tracks	22	72	1,350
8. Swinging tracks after burning	32	68	1,200
3. Locked punch-packer	12	66	1,150
7. Snagged tree trunks	8	56	900
9. Untreated (control No. 1)	28	48	700
11. Punch-packer after burning	6	44	650
10. Punch-packer	16	32	400
5. Burned	0	28	350

* Taken from Fig. 1, "Relationship between number of trees per acre and per cent stocking—1 mile method", Dembicki, 1953.

In some cases the per cent stocking figures presented in Table 2 are higher than those recorded at the conclusion of the second season (Crossley, 1952). Subsequent germination may account for some of this, although the detailed quadrat records suggest that very little germination took place until 1953, and cotyledonous seedling tallies are not included in this Table. The more likely explanation is the suggestion that the 1953 tally was more accurately complete owing to the fact that by this time the bigger seedlings were more easily detected in the long grass with which they were competing.

In 1952 the marginal stand of spruce produced a light seed crop. No data are available on the amount of seed distributed over the study area, but Table 3 presents the stocking that resulted at the conclusion of the first season after germination.

TABLE 3.—COMPARATIVE RESULTS IN 1953 ON SEED-BEDS TREATED FIVE YEARS PREVIOUSLY, IN GERMINATION THAT ORIGINATED FROM A NATURAL SEED SUPPLY

Plot No. and Treatment	Per cent Stocking of 1953 Germinates
1. Athens disc	55
2. Athens disc after burning	28
4. Athens disc and punch-packer	21
6. Bull-dozer	16
11. Punch-packer after burning	12
12. Swinging tracks	11
5. Burned	8
7. Snagged tree trunks	6
3. Locked punch-packer	5
10. Punch-packer	5
9. Untreated (control No. 1)	5
8. Swinging tracks after burning	4

TABLE 4.—OVER-ALL STOCKING RESULTS IN THE AUTUMN OF 1953, ARRANGED IN ORDER OF SUCCESS IN RELATION TO INITIAL ARTIFICIAL SEEDING

Plot No. and Treatment	Area Initially Seeded Artificially		Area Initially Allowed to Seed Naturally	
	Per cent Stocking			
1. Athens disc	96	(16)*	60	(34)
6. Bull-dozer	90	(0)	46	(12)
4. Athens disc and punch-packer	88	(4)	50	(14)
2. Athens disc after burning	88	(8)	40	(20)
2. Swinging tracks	76	(4)	30	(8)
3. Swinging tracks after burning	70	(2)	34	(2)
3. Locked punch-packer	66	(0)	16	(4)
7. Snagged tree trunks	58	(2)	14	(6)
). Untreated (control No. 1)	50	(2)	32	(4)
1. Punch-packer after burning	46	(2)	18	(12)
5. Burned	40	(12)	2	(2)
). Punch-packer	38	(6)	18	(2)

* The figures in brackets represent the increase in per cent stocking figures presented in Table 2.

DISCUSSION

It is apparent from the results obtained that the light natural seed crop 1948 was mostly destroyed by birds, rodents and insects before the seeds ad a chance to germinate. It is, therefore, not possible to obtain sufficient ata from this source from which to draw conclusions regarding comparative ed-bed receptivity.

On the other hand the broadcasting of seed on half the experimental area, amounts similar to a heavy natural crop, has provided us with valuable data om which some interesting results are appearing. Since the individual study adrats were protected from bird and rodent seed loss by wire screening, ey provide some comparative figures on seed-bed receptivity, with major riations in the amount of seed available for germination eliminated. From ese data it is safe to conclude that scarification has effectively increased the rest floor's receptivity to spruce regeneration, and that the more completely e mineral soil is bared and compacted the better the results in initial ger-nation. The subsequent mortality on the study quadrats does not present ch a clear picture. Mortality varies from 57 per cent to 100 per cent by eatments at the conclusion of the five-year period, but there is little evidence any relationship between mortality over the five-year period and the nature the seed-bed. The fact that fifth-year survival figures again indicate a sitive relationship between themselves and degree of scarification is purely reflection of the receptivity of the seed-beds. The most receptive seed-beds rminated such a large number of seedlings that they were apparently able in ne instances to absorb a high rate of mortality and still rank with the best at conclusion of the five-year period in number of survivors per acre.

Soil heaving took a heavy toll of seedlings during the first three years on all adrats where treatment had exposed the mineral soil. Loss from this source s most pronounced the following spring after germination and did not cease rely until the fourth spring. By this time an insulating blanket of vege-ive debris provided more protection from frost and the seedlings had parently become sufficiently well-rooted to withstand the strain.

In most regeneration surveys it is customary to consider that a five-ye old seedling has become established. Indeed, the mortality curves present in Figure 1 generally flatten out after the third year and therefore support su a contention. If this is the case, most of the study quadrats are far too dens stocked and even the poorest are at present supporting sufficient seedlings produce a stand.

Leaving these figures derived from detailed tallies of the study quadra we turn to examination of the stocking data taken from the artificially seed plots as a whole. By Federal Forestry Branch standards (Candy, 1951), wh are based on the one-milacre stocked quadrat method, at the conclusion of t fifth growing season four treatments have resulted in a fully-stocked conditi (80-100 per cent). They are those areas scarified by bulldozer, Athens d with punch-packer in tandem, Athens disc alone, and Athens disc after previ burning. Three treatments have resulted in well-stocked stand (60-79 per ce and the remaining four are understocked. The "untreated" control (No. 9 48 per cent stocked and therefore is classified as under-stocked, but it is f that the clearing of slash from this plot may have resulted in a more recepti seed-bed and this area cannot be considered a true control. The "untouche controls were not artificially seeded beyond the boundaries of the study qu rats themselves, but since all the seedlings on these quadrats have succumb by the third year, we can consider stocking here as a complete failure.

Some investigators think that the standards set by Candy are too hig and under conditions existing in the Pacific Northwest, Dembicki (1953) co siders that 40 per cent is a standard that provides a generally acceptable mi mum for adequate stocking. Such a standard would be met by all but t of the treatments used in this investigation under artificial seeding conditio The two exceptions are the area burned, and the area treated with the punc packer.

The effect of loss of seed to birds, rodents and insects can be approxima by comparing the actual number of surviving seedlings per acre on the p tected quadrats (Table 1, Col. 9) with the estimated number under unprotec conditions (Table 2, Col. 3). While the data are not as strong as we wo wish, they do suggest that over 90 per cent of the seed broadcast over the a was destroyed before it had a chance to germinate. It is apparent that un heavy seeding conditions, the initial consumption of seed has resulted acceptable per-acre figures of fifth-year survivors and the loss has therefo been beneficial.

On the other hand even the most receptive seed-bed has not resulted i stand that meets minimum acceptable stocking standards five years a germination if it received its seed from a light seed source and was subject normal loss before germination. This suggests that only a heavy seed c will satisfy the enormous demands made by the forest fauna while still leavi sufficient for regeneration purposes.

Since seedlings that have survived only the first season cannot be cons ered as established, it is not customary to include them in stocking studi However, they have been presented in Table 3 for the purpose of indicating t comparative receptiveness of each seed-bed treatment to germination five ye after such treatment took place. There can be little doubt that many of th will succumb in subsequent years, and such progress will be watched w interest. On the other hand some will probably survive and will help to t the place of those older seedlings that will undoubtedly succumb.

CONCLUSIONS

The results obtained to date continue to support the following conclusions rived at in the initial published report:

(1) The scarification of the forest floor on a non-reproducing cut-over area effectively increases its receptivity to spruce regeneration.

(2) The more completely the mineral soil is bared and compacted, the better the results appear to be.

Following a longer period of observation, these additional conclusions pear to be justified:

(3) Soil-heaving on scarified soil is a major factor in seedling mortality during the first three years after germination, but is negligible after that time.

(4) A heavy seed crop is necessary if the demands of birds, rodents and insects are to be satisfied before germination takes place; or, stated in another way, the most receptive seed-bed has not resulted in a stand that meets minimum stocking requirements (40 per cent—Dembicki 1953) five years after germination, when its seed originated from a light seed crop. (This inevitably leads to the suggestion that the poorer the seed year the more intensive must be the soil treatment. Whether the converse is also true must await further mortality data over subsequent years.)

(5) The effect of treatment still remains evident in degree of seed-bed receptivity five years after completion.

A final conclusion to be drawn from this study is that future experiments stigating cultural aids to obtaining increased regeneration and adequate vival should be designed to include the effect of the amount of seed lost to st fauna upon the results obtained.

SUMMARY

A study was undertaken on the Kananaskis Forest Experiment Station, erta, to investigate the effect of fire and of certain mechanical equipment ne preparation of seed-beds receptive to white spruce reproduction on inade- ately restocked cut-over areas. Soils were scarified by 11 different methods ng the summer of 1948. An initial report based on two years data prepared and published (Crossley, 1952).

The present publication is based on three years additional data, and rts that all methods of soil treatment under study have proven more tive than the untouched control, that several of them satisfy even the most anding stocking requirements, and that certain degrees of improved ptivity are still evident five years after treatment. In addition it is apparent loss of seed prior to germination is a factor of major importance, and seed crop evaluation is intimately connected with choice of seed-bed ment.

The investigation will continue.

REFERENCES

Y, R. H. 1951.—Reproduction on cut-over and burned-over land in Canada. Canada, Dept. Resources and Development, Forestry Branch, Silv. Res. Note No. 92.

LEY, D. I. 1952.—White spruce reproduction resulting from various methods of forest soil scarification. Canada, Dept. Resources and Development, Forestry Branch, Silv. Res. Note No. 102.

CKI, H. 1953.—A recommended regeneration survey system. U.B.C. Forest Club Research Note No. 7, University of British Columbia.

Date Due

		MAR 2 8 RETURN	
DUE CAM	NOV 13 '80		
NOV 13 RETURN		DUE CAM	APR 01 '95
DUE CAM	AUG 20 '84	MAR 2 6 RETURN	
AUG 2 0 RETURN		DEC 01 1995	
DUE CAM	APR 20 '87	RETURN DEC 4 '95	
APR 07 RETURN		RETURN SEP 14	
DUE CAM	OCT 08 '87		
OCT 0 8 RETURN			
DUE CAM	MAR 30 '89		
MAR 03 RETURN			
Due Cam	DEC 03 1991		
DEC 0 2 RETURN			
DUE CAM	DEC 07 '92		
DEC 0 2 RETURN			
Due Cam	OCT 27 1993		
OCT 2 7 RETURN			
Due Cam	APR 10 1994		

NERY

SD 145 T25 NO-0010
CROSSLEY DESMOND IVAN 1910-
SURVIVAL OF WHITE SPRUCE
REPRODUCTION RESULTING FROM
39850025 SCI

000018210161

SD 145 T25 no.0010
Crossley, Desmond Ivan, 1910-
Survival of white spruce
reproduction resulting from
39850025 SCI

no.10

2476943

SCIENCE
CAMERON LIBRARY